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AN
ESSAY
ON THE
THEORY AND PRACTICE
OF
BLEACHING,
WHEREIN
THE SULPHURET OF LIME IS RECOMMENDED
AS A
SUBSTITUTE FOR POT-ASH.

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THEORY AND PRACTICE

1651/166





TO THE

RIGHT HONORABLE AND HONORABLE

THE

LINEN BOARD,

THE FOLLOWING

E S S A Y

IS INSCRIBED BY

THEIR MUCH OBLIGED,

AND VERY HUMBLE SERVANT,

THE AUTHOR.



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PREFACE.



SOON after I sent in a report on the *sulphuret of lime* to the Linen Board, they requested to have some experiments made upon it in their presence, at the Elaboratory of the Dublin Society in Hawkins's-street; which led to a lecture upon the general principles of bleaching, illustrated with suitable experiments.

At that time, I had no idea of publishing any thing upon the subject; but finding that it was the wish of the Rt. Hon. John Foster, Speaker of the House

House of Commons, and of the Rt. Hon. Isaac Corry, who were present, to have it printed for the use of the bleachers, I readily assented, feeling great satisfaction in having it in my power to comply with the wishes of these gentlemen, but particularly with the wish of the man * who has so materially contributed to the present prosperous state of the Linen Manufacture of this kingdom, and who so disinterestedly makes it his study to forward every other manufacture and institution likely to be productive of national good.

I also undertook the task with some degree of alacrity, when I considered that any treatise likely to throw light upon the principles of this art, must not only be acceptable, but ultimately of infinite

* The Rt. Hon. the Speaker.

infinite service to the bleacher, whose process is truly chemical in all its stages.

When I first sat down to write, I intended to confine myself to the mere bleaching of the cloth by means of the oxygenated muriate of lime, and the *sulphuret of lime*; but I afterwards conceived, that it would be much better to give a full narrative and theory of the whole process in the old and new method, and also, to commence with the green *flax* so as to begin at the right end of the chain, and to avoid chasms, to take it up link after link, according to the position or arrangement which the finger of nature seemed to point out to me.

In so short an essay confined to the one object, this could be no difficult task; however, I will observe, that in

all scientific works, much depends upon good arrangement, for without it, there can be no perspicuity; and as chemistry embraces such a vast field, indeed I may say, all the materials of this globe, and most of the phænomena which come within our reach, in no one branch of science is arrangement more necessary, or more difficult to be accomplished.

As the following essay was written for the use of the bleachers only, and as the majority of them are not well acquainted with the theory of chemistry, I have endeavoured to write it in as simple and familiar a style as the nature of the subject would admit: I have overlooked minutiae altogether unnecessary to the bleacher, which, I should hope, the man of science will excuse.

The

The few technical terms, which I was obliged to use, are explained at the bottom of the page, which I considered more convenient to the reader than to have them set apart by themselves.

I now beg leave to say a few words to my philosophical friends. Nine years have elapsed since I addressed them last; at that time, when I published my *Comparative View*, the controversy ran very high between the *Phlogistians* and the *Antiphlogistians*. For a considerable time have I stood alone in England, where I then resided, being the first who adopted the antiphlogistic doctrine, and the only man who had expressly written in favour of it in the English language.

During this interval, nothing worthy of notice has appeared for or against
either

either doctrine, and now, the antiphlogistic theory is received by all the philosophers of Europe, at least, by those who deserve the name of philosophers.

I have seen, with pleasure, that, since the controversy was laid aside, and the true theory of chemistry adopted and fixed upon a firm basis, most chemical philosophers have applied their knowledge and talents to the improvement of the arts and manufactures, which is the ultimate and grand object of the science.

I have seen also, with great astonishment, that some experiments which I made and published, were a considerable time afterwards adduced as *new* discoveries on the continent.

First, *Monsieur Fourcroy* published in the year 1791*, as a new discovery, the

* See *Medecin éclairé par les sciences physiques*
Tom. 2d. pag. 321. No. X 1.

the presence of bile in the blood; or rather, the conversion of some of the principles of the blood into a substance resembling bile: This I had done some years before him by the mediation of the nitrous acid. For the truth of what I assert, see pages 162 and 163 of my *Comparative View*, published in the year 1789.

Secondly, *Monfieur Vanquelin* has published as his discovery, in the *Journal des Mines* "a new method of determining the quantity of carbon contained in steel." See the extract from it in the *Annales de Chimie* for the year 1797. This new method is by means of the volatile sulphureous acid, and for the discovery I will refer to my *Comparative View*, pages 49, 50 and 51, where the justice of my claim will evidently appear.

I by

I by no means impeach the above philosophers with plagiarism; I have too much respect for the high character they have acquired in the scientific world to suspect them of such conduct, but that it has been, at least, an oversight, must be allowed.

The chemical properties of the sulphureous acid were very little known, if at all, when I published my experiments upon the subject. It first drew my attention with a view solely of investigating the truth of the *antiphlogistic theory*, and it furnished me with *incontrovertible* arguments in favor of that doctrine. Amongst its various properties, that of dissolving iron without the *production* of hydrogen gas, at the same time that the *whole* of the carbon and sulphur contained in the iron were left behind,

behind, impressed me most, by pointing out the importance of it as a *menstruum* for the analysis of iron or steel in an easy, simple, and certain way.

The celebrated Bergman laboured hard to analyse the different kinds of iron and steel, and made the most of the menstrua which the chemistry of his days afforded: He ascertained only the presence of those substances contained in iron; nor was it possible to find out their proportion by any means hitherto discovered, until the happy application of the sulphureous acid in that way.

Sulphuric acid consists of one part of sulphur, and two of oxygen chemically united. When iron is introduced into this acid diluted with four or five times its bulk of water, it is dissolved, and
hydrogen

hydrogen gas is copiously produced, which is now allowed to come from the water. The sulphureous acid contains but equal parts of oxygen and sulphur*, that is, one half the quantity of oxygen which the sulphuric acid contains, and yet it dissolves the iron without the decomposition of water. These two facts contrasted, opened to my view quite a new theory, which I have already submitted to the opinion of the scientific world, and as an explanation of it would be too long for my present limits, I will refer to my *Comparative View*, from page 36 to page 61.

Let us now consider how far the French method of accounting for the decomposition of water may be reconciled to the above facts.

The

* This I have shewn by experiment. See my *Comparative View*, pages 80 and 81.

The French philosophers suppose, from the attraction of sulphuric acid for an *oxyd* of iron, that this metal decomposes the water in order to oxygenate itself, at the instant of its union to the acid, and thus liberates its hydrogen: This, they tell us, takes place, by virtue of a predisposing affinity: that such an affinity exists, I know by experience; but it does not prevail here*, for the sulphureous acid, as containing less oxygen, and consequently having stronger affinity to metallic oxyds, should, upon the above principle, be a more powerful agent in decom-

* The brilliant experiment of Mr. Tennant, of Cambridge, by which he decomposed carbonic acid gas, by passing the vapour of phosphorus through heated carbonate of lime, the oxygenation of iron pyrites, and the formation of nitrous acid, from the union of the *azote* and *oxygen* of the atmosphere by calcareous matter, are all striking instances of this kind of affinity.

decomposing water than the sulphuric acid.

Other theorists again tell us, that the sulphuric acid unites first to the iron, and that the compound decomposes the water. But should not the compound resulting from iron and sulphureous acid, as containing one half less oxygen, produce the same effect? Even a man who is not a chemist must see the inconsistency of such a doctrine.

It would be impossible to detect the fallacy of the above theory without the aid of the experiment of the sulphureous acid, which shews that abstracted reasoning, be it ever so plausible, is not to be relied upon.

The phenomena of *day* and *night* might appear equally well explained by supposing the *sun* to revolve round the earth, as the earth to turn round upon its own axis, every twenty-four hours,
were

were our knowledge of astronomy confined to those circumstances alone; but it is by extending our views to the motion and harmony of the whole planetary system, that the delusion of such a doctrine can only be detected. It is just so with chemistry; the concatenating a few facts here and there, is not sufficient to establish a doctrine; it is necessary the theorist should traverse the whole field, accurately examine all the facts upon record, find out their proper position and relation to each other, and see the arrangement, harmony, and symmetry of the whole superstructure at one view; for that doctrine must be false which contradicts itself in any one single point.

The theory of the decomposition of water during the action of acids upon
the

the metals, is not the only instance in which I differ from the French chemists; I only adduce it as being connected with the discovery of the sulphureous acid, as a menstruum for the analysis of steel.

Indeed, except that alone of the nonentity of phlogiston, our mode of reasoning is very different. They have *asserted* the truth I will allow, but that in an abstracted and unconnected manner, without sufficient conviction, for all the phenomena or facts adduced seemed equally well explained upon the phlogistic principle.

I have connected the whole, and reduced it to a system, and made use of demonstrations, which in my opinion are not to be invalidated or contradicted, until the order of natural things assume a different aspect.

Some

Some of my readers may probably suppose, before they enquire into this subject, that I exaggerate in my own behalf: But assumed modesty upon such an occasion as this, would be weakness indeed, and affected diffidence downright folly.

Every man who writes should deliberately weigh his opinions in the scale of his own understanding, and be convinced according to his judgment that he is right, before he presents them to the public. Every liberal minded man should also be open to conviction, and feel a pleasure in having his errors corrected: but until this happens, confidence and firmness are justifiable.

I will now conclude by observing, that one modification of the antiphlogistic doctrine escaped the French theorists

rists altogether; viz. the decomposition and recomposition of water during the oxygenation of metals, and I may add, other inflammable bodies, in the common temperature of the atmosphere.

This I have shewn by experiment, with a view, principally, of proving the constituent principles of water, which were disputed at the time. I shall give the following short extract of it from my *Comparative View*, page 13. "Iron moistened with water, and confined by mercury in a glass cylinder, will yield inflammable air; iron, treated in the same manner, and confined with dephlogisticated air, will produce no inflammable air, but the air will be diminished. Iron will yield no inflammable air if it be confined in very dry dephlogisticated air, neither will the
air

air be diminished, nor will the iron tarnish, in *any* length of time; hence it appears, that iron has no effect on air in a common temperature, but that it is the water which is decomposed, and that the dephlogisticated air and the inflammable air of the water unite at the very instant of the liberation of the latter, and recombine water.*"

From the foregoing data, it is evident that the decomposition of water does not take place here, in consequence of a double affinity occasioned by the oxygen gas, as the iron alone decomposes it, and liberates its hydrogen in a gaseous state.

That a metal should take oxygen from hydrogen with more facility than from

* When the above extract was published, the new nomenclature was not adopted.

from caloric, which retains it with less force, proceeds from two concurring and opposite causes, viz. the aggregate attraction of the ultimate particles of the metal to each other on the one side, and on the other, partly from the affinity of oxygen to caloric, but principally from the distance by which the atmospheres of caloric round each particle of oxygen keep them from the surface of the metal, in a word, they are by these means kept beyond the striking distance of their mutual attraction. By way of analogy, I will adduce a single fact to illustrate this point.—It is well known, that marine acid has very strong affinity to calcareous earth, and yet perfectly pure and dry calcareous earth will not condense dry marine acid gas, when both are confined in a glass cylinder over mercury,

mercury, but as soon as a small quantity of water is introduced, the gas is condensed, and then unites to the calcareous earth.

Although water condenses the marine acid gas, it has less affinity to it by much than the calcareous earth, for strictly speaking, water and marine acid gas do not form a chemical union. I am inclined to believe that the affinity, or rather the capacity of water for caloric, and its attraction to the gravitating matter of the marine gas at the same time, although very weak, co-operate with each other in producing the effect. I also suspect, that a predisposed affinity of water for a portion of the caloric of the oxygen gas, assists the hydrogen, in its nascent state, to condense it so as to constitute water.

d

The

The rapid and easy condensation of oxygen gas by nitrous gas, (which have but a weak attraction to each other) in the common temperature of the atmosphere, takes place upon the same principle, and is a striking instance of this kind of affinity proceeding from caloric, for the compound (*nitrous acid*) retains the whole of the caloric of the oxygen gas in its condensed state. I am confident the agency of caloric in this way, is more general than chemists are aware of.

From the above statement, the circumstances which oppose the union of metals to oxygen gas are very obvious: But that metals, when the aggregate influence of their particles upon each other, (being the principal obstacle) is removed by caloric, are
capable

capable of decomposing oxygen gas, and uniting directly to its base or gravitating matter, might be proved by a variety of well connected facts, were it considered necessary.

About four years ago, a very ingenious pamphlet appeared in the name of a Mrs. Fulhame, in which this doctrine of mine respecting the decomposition, and recomposition of water has been adduced and extended to every species of oxygenation, and even to the deoxydation of metals in every degree of heat. I did not think myself warranted when I had written, and much less so now, upon a more mature deliberation, to apply it in that general way.

Had this fair author read my book, and indeed I suppose she did not, (having quoted every other treatise upon
the

the subject,) no doubt she would have been candid enough to do me the justice of excepting *me* from the rest of my co-operators in science, when she told them they erred for having overlooked this modification of their doctrine, and also when she adduced it as an original idea of her own.

As to the reduction of metals, I have said so much already upon it, I have scarcely any thing to add, for I have considered the subject in every possible point of view, not excepting the agency of hydrogen in its nascent state, when water is decomposed in contact with those oxyds which retain the oxygen with less force than hydrogen attracts it, as the following paragraph, taken from my *Comparative View*, page 280, will shew.

“ But

“ But as water is present, a portion
“ of it is also decomposed, by which
“ means we obtain inflammable air.
“ Whether the inflammable air itself
“ at the instant that it is deprived of
“ its dephlogisticated air, may not con-
“ tribute to the reduction of the mer-
“ cury, by uniting to its dephlogisti-
“ cated air, and reproducing water, is
“ what I cannot pretend to determine;
“ although from the attraction of the
“ matter of light inflammable air to
“ fire, together with the interference
“ of the Prussian acid, I am rather in-
“ clined to suppose it does not.”*

Although I do not agree with Mrs.
Fulhame, as to the decomposition of
water

* This relates to the reduction of the oxyd of mercury, held in solution by the prussic acid, when iron filings and sulphuric acid are introduced.

water during the reduction of metals, yet I consider her experiments very interesting, and well worthy the attention of chemical philosophers. It appears from those ingenious experiments, that the different metallic salts, that is, all the metallic oxyds saturated with acids, deposited into the interstices of silk in a state of solution in water, were reduced by hydrogen gas in the ordinary temperature of the atmosphere.

“The hydrogen of the gas,” says she, “unites to the oxygen of the water, while the hydrogen of the latter unites in its nascent state to the oxygen of the metal, reduces it, and forms water.” She also supposes, when charcoal is used, even in the high temperatures, that water is decomposed, its oxygen uniting to the carbon,

carbon, while its hydrogen unites to the oxygen of the metal and reduces it.

I would observe, that the pure oxyds of metals, (those of the noble metals excepted) free from acids, or acid bases, and deposited in silk, linen, or calico, and moistened with water, will not be reduced by hydrogen in a common temperature, and some of them not completely so in any degree of heat; hence it follows, that the acid basis itself acts a part here, which Mrs. Fulhame was not aware of; besides, were hydrogen capable of reducing all the metals, its affinity to oxygen must be superior to any of them, which a variety of well attested facts will refute.

And again, if hydrogen were the reducer of all metallic oxyds, the different metals would not only precipitate
each

each other indiscriminately without any order or marked affinity, from their solution in acids, but *iron* would precipitate *iron* in its metallic state; *copper* would precipitate *copper*; and so with *tin* and *zinc* and all other metals. It is, perhaps needless to enter more largely into this subject, therefore I will drop it here.

I now beg leave to assure Mrs. F. before we part, that I read her book with great pleasure, and heartily wish her laudable example may be followed by the rest of her sex; particularly by those who possess talents and means for making chemical experiments.

ESSAY





BLEACHING.

SECTION I.

On Flax.

RIPE Flax when pulled out of the ground, is composed of four distinct substances, viz. a thin cortex, a green sap, the fibrous or flaxy part and the ligneous matter.

The sap or succulent part is again composed of an extractive matter and water, to separate these different substances from the flaxy part, it must first be submitted to the following

B

process.

process. As soon as pulled it is to be steeped in soft water until the putrefactive fermentation takes place. This degree of fermentation commences with the succulent part as being more susceptible of decomposition than the rest, for the fermentation of animal or vegetable matter is a decomposition of their constituent parts.

Were the flax to be continued long in this state, the whole substance of it would be decomposed or destroyed upon the same principle that malt is injured by too long steeping, or that wort loses its substance by too long a fermentation. It must therefore be taken out of the water while as yet green, and before the whole of its sap is separated; but by spreading it thin upon the ground, and exposing it to
the



the air, the remainder (being already on the wing of decomposition) is soon carried off or bleached out by the agency of the oxygenous part of the atmosphere.

Hard waters, which generally contain but a small portion of selenite (sulphat of lime) sometimes common salt and muriate of lime, injures the flax, for it soon rots when steeped in such water. This circumstance seems difficult of solution.—We know very well that these saline substances are strong septics in small quantities, but particularly the sulphat of lime which possesses this property in a higher degree than any other saline body, as observed by Madame D. Arconville* who,

* The wife of a president of Parliament at Bourdeaux.

who, it seems, has made a variety of experiments on the septic powers of different saline substances.

I will also enumerate by way of analogy, the following striking facts, viz. that a small quantity of common salt will promote the putrefaction of flesh or fish, while a larger quantity will preserve them—that a small quantity of salt taken with our aliment will promote digestion, while an over dose will produce the contrary effect—that a small portion of salt mixed with vegetable composts, will help to fertilise, although a large quantity will render the soil sterile—and lastly, that sea water which contains salt but sparingly, will produce similar effect, with hard waters, upon
dead

dead animal and vegetable matter, but in a more eminent degree.

From these data one is led to believe, that hard waters act too powerfully on the flax, by extending the putrefactive process or decomposition to the fibrous, as well as the succulent part, pretty much about the same time. But to return, the flax when in a fit state to be taken off the ground, is of a greyish white colour, very flexible and tenacious, and wholly free from the extractive matter or sap.

Nothing now remains but the wood and flax. The wood is an hollow little tube covered over very compactly with the flax; to separate the wood it must be kiln-dried, in order to render it frangible or brittle, but care must be taken not to apply too much heat for fear of injuring the flax. It is next to

be

be beat or broke, by which means the flax is not only divided into small fibres, but most of the wood is separated, and the part which adheres, is reduced to small fragments. To separate these again, the flax is to be scutched in small parcels at a time, either by manual labour or mills contrived for the purpose.

Hackling is the last process, which is nothing more than drawing, or if I may be allowed the expression, combing the flax in small parcels at a time, through a pile or group of polished and sharp iron spikes placed firmly in wood thro' an iron plate. The spikes are placed pretty close together; the first hackle (for different hackles must be used) is coarse, the second finer, and the third finer again.

The

The process of hackling answers a double or triple purpose; first, it divides the fibres of the flax, as much as this can be effected by mechanical means; 2d, it separates the minute fragments of wood which escaped the process of scutching; and lastly, it separates the short coarse flax, commonly called tow.

Spinning and weaving are too well known to need description, and also the preparation which the yarn requires previous to its being set in the loom.

SECTION

SECTION II.

On bleaching in the old method, with general observations on the alkalies.

THE linen as it comes from the loom is charged with what is called the weaver's dressing, which is a paste of flour boiled in water, and as this is brushed into the yarn of the warp, before it is wove, it is somewhat difficult to separate it when dry. To discharge this paste, the linen must be steeped in water for about forty eight hours, when this extraneous substance undergoes a kind of fermentation which does not extend to the substance of the linen itself, upon the same principle that the green sap is disengaged from the flax without injury to its texture.

When

When the linen is well washed after this last process, it contains nothing that water can separate; it is of a greyish white colour, although the fibres of which it is composed, when divested of every adventitious substance, are naturally very white.

The matter which thus colours the linen, is of a resinous nature, insoluble in water, and from its intimate union or diffemination through the very fibres of the flax is difficult of separation, even by those substances which have a solvent power over it.

To disengage it however, in as cheap and expeditious a manner as possible, without injuring the texture of the fabric, is the sole object of the process of bleaching.

c

Pot-ash

Pot-ash is the first menstruum which should be used in bleaching; but perhaps it may not be amiss to make some observations on its nature and general properties, before we apply it in this way.

All vegetable substances, from the smallest weed up to the oak, afford more or less ashes when burned in open air; which ashes contain different kinds of earths, neutral salts, and a small portion of pot-ash or alkali.

A given quantity of weeds yields more pot-ash than woods, as Mr. Kirwan has observed in his excellent paper on alkalies, in the transactions of the Royal Irish Academy for 1789.

I understand the Irish farmers burn their weeds (being in every other respect useless) every year, in order to obtain the alkali; hence it is needless to say any

any thing upon this head, only to observe, that pot-ash is the same in whatever climate, or from whatever vegetable it is obtained.

The learned Dr. Watson, formerly professor of chemistry at the University of Cambridge, and now bishop of Landaff, has shewn that 1300 tons of dry oak yield 15 tons of ashes; and that these ashes again afford only one ton of pot-ash; hence it appears that we cannot expect any great supply in this country, but that we must ever look up to foreign nations, which abound with forests for this useful article.

To separate the pot-ash or alkali from the other ingredients in the ashes, they must be put into ten or twelve times their weight of boiling water, or according to chemical language, *lixivated*
in

in water. By this means the pot-ash, (from its great solubility) together with the other saline substances, are dissolved, while the earthy part, being nearly insoluble, is left behind.

The solution or lixivium is to be drawn off clear from the dregs, and evaporated to dryness in iron pots, and hence it is called pot-ash.

Pot-ash is far from being a pure salt; it contains from 20 to 25 per cent. of impurities, consisting principally of sulphat of pot-ash* and carbonic matter.

To free the pot-ash from carbon † or any other inflammable matter it may contain, it is exposed to the joint action of

* Sulphat of pot-ash is a neutral salt, composed of pure pot-ash and oil of vitriol, now called sulphuric acid.

† The term carbon is derived from carbo, the latin word for charcoal.

of air, and a moderate red heat, upon the bed of a reverberating furnace. Thus, the inflammable matter being burned out, the pot-ash, from being of a darkish grey colour, acquires a pearly white; it is hence called pearl-ash.

Pearl-ash contains from 10 to 12 per cent. of impurities, mostly sulphat of pot-ash, and sometimes a small portion of muriate* of pot-ash. These salts must have been yielded by the wood, and dissolved by the large quantity of water necessary to separate the pot-ash from the ashes.

I more than once obtained near 20 per cent. of sulphat of pot-ash from the pearl-ash imported here; this great portion of sulphat of pot-ash could have
never

* Muriate of pot-ash, a neutral salt, consisting of marine acid and pure pot-ash.

never been a natural product, but must have been an artificial adulteration ; and indeed, circumstances have convinced me that it must be so.

During a mineralogical excursion through England in the summer and autumn of the year 1785, the different manufactures which fell in my way, were not passed over. Upon enquiring of the distillers of aquafortis (nitrous acid) how they disposed of the large residuum left in the still (when the acid was carried over) which is sulphat of pot-ash, and which is of little or no use in the arts, they informed me it was bought up by the Irish merchants.

Sulphat of pot-ash, when ground down, cannot readily be distinguished as to its external appearance from pearl-ash, and being so much cheaper than
the

the latter, is well calculated for the above fraudulent purpose.

By no means do I intimate that this is a common practice, as from experience I know the contrary.

However, to pass it over in silence would be unpardonable, when it is considered that the bleacher is at the expence of an article of no use whatever in bleaching, and that, by the adulteration, the proportion best known by experience to answer his purpose is varied; by which means his process, although not altogether frustrated, must be materially retarded.

Sulphat of pot-ash is only soluble in about sixteen times its weight of water, in the temperature of 60° , while real pot-ash is soluble in its own weight of water, in the same temperature;
hence

hence they are easily separated in the following simple manner, viz. three pounds of pearl-ash and two quarts of water should boil together for a few minutes, then be removed from the fire and suffered to stand for twenty-four hours, when the clear liquor is to be decanted off. Half a pint more of cold water is to be poured upon the dregs, and this again drawn off when clear : The insoluble salt is afterwards to be well dried and weighed, which, being a foreign salt, will give pretty nearly the quantity of impurities in the pot-ash.

I would recommend the above mode of analysis to the bleachers before they purchase or use their pot-ash.

Common pot-ash when freed from earthy, inflammable, and foreign saline matter is still impure, being chemical-
ly

ly united to carbonic acid gas (fixable air*.) This combination does not altogether deprive it of its detergent property.

To obtain pot-ash perfectly pure, it must be deprived of the carbonic acid: This is effected by quick lime, which has greater affinity to the acid than the pot-ash has.

The lime is to be slaked and sifted, and the pot-ash dissolved in water; then mixed and boiled†, and lastly, strained or filtered, or suffered to subside. The clear liquor is a solution of pure pot-ash, and should not contain a particle of
D lime.

* Called carbonic acid, as the matter of charcoal is one of its constituent principles.

† Upon a large scale there is no necessity for boiling the mixture, but to suffer it to stand for a few days before the pot-ash is drawn off. The mixture should be stirred pretty often.



lime. This is what is commonly called soap-lye; the alkali requiring this treatment before it can make soap.

Pure pot-ash, according to our present knowledge of chemistry, is a simple elementary substance, and in this state, being uncombined or uninfluenced by any body whatsoever, its attraction is much encreased for those substances to which it has affinity; such as fuet, oil, resins, gums, and in short, all animal and vegetable inflammable matter. Its attraction to animal matter is such, that it instantly corrodes or dissolves the skin and flesh of animals when brought into contact with them; hence it is called *caustic lye* or *caustic alkali*; while the carbonated pot-ash from being much weaker, is termed *mild alkali*.

It

It is upon the foregoing principle that soaps are made, which consist of animal or vegetable fats and pure alkaline lye. Soaps, although composed of lye and oils, or grease, or fats, are still possessed of a detergent property, that is to say, they are capable of combining with more grease or inflammable matter, and dissolving a large portion of it by the assistance of heat. This comprehends the whole theory of washing or cleansing of linen.

+ *Mild pot-ash* (the lye united to carbonic acid gas) is a more powerful detergent than soap; so much so, that its frequent use in the washing of linen would destroy its texture, and wear it down too soon.

Caustic lye or pure pot-ash has a similar effect with the mild, but in a higher

or Soda

higher extreme; I would however suppose, that it might, when reduced, or sufficiently diluted with water, be advantageously substituted for soap in the cleansing of coarse linens, particularly in hospitals.

Caustic, or pure pot-ash, should ever be used by the bleachers, as having a greater solvent power over the colouring matter of the linen than the mild; besides, a given quantity of the former will go farther than the same quantity of the latter.

The immediate application of lime to the linen, either by itself, or mixed with pot-ash, should be avoided; for although it has the property of bleaching, it destroys the texture of the cloth. I have tried it in various ways and proportions, and don't hesitate to forbid the use of it.

The

The caustic lyè, it is true, unless properly diluted, is capable of injuring the cloth; and so is sulphuric acid (oil of vitriol) which is known to be used with great safety as a souring.

Marine plants afford by incineration a substance possessing the same property with pot-ash, particularly so far as relates to bleaching and soap-making. This substance, being perhaps originally obtained from a marine plant called kali, hence derived the name alkali, which is now the common name for both substances; for hitherto, only two fixed alkalies, and one volatile have been discovered, and perhaps in nature there are no more. The latter alkali is the product of the animal kingdom, and being remarkably volatile, is never used in bleaching.

The

The two fixed alkalies are distinguished from each other by the names *vegetable alkali* and *mineral alkali*, the latter being found in great abundance in the mineral kingdom, united to muriatic acid in the state of common salt. It is found native, united only to carbonic acid gas, in hot climates, particularly in Egypt, and many other parts of the East, in a state of efflorescence upon the surface of the ground. It is also found native in cold countries, particularly in Russia. Most of what is used in England and Ireland is extracted from the ashes of marine plants. Those which come from Alicant, and many countries bordering on the Mediterranean, are the richest. The plants called *soza*, *salicornia*, *gazulla*, and *barilha*, afford most alkali; particularly

larly the former and the latter; hence the ashes, which are a greyish or bluish black fused mass, go by the name of barilha; and the alkaline salt, when separated from foreign impurities, is called soda.

The marine plants of our own shores afford soda in very small proportions. Their ashes, which in external appearance cannot be readily distinguished from barilha, are called kelp. The latter contains more foreign salts than the former, particularly sea salt. These two substances are often mixed with each other, a species of imposition not easily detected but by analysis. This is effected by boiling the ashes, first reduced to powder, in thrice their weight of water, and then filtering the liquor. The residuum on the filter is again to be boiled with half the quantity

tity of water, and filtered or strained. The clear liquors are to be mixed while hot, and set by to crystallize.

Most of the soda when extracted from either barilha or kelp, is caustic, and will not crystallize in that state; therefore the solution must stand five or six days exposed to the air, in order to imbibe carbonic acid gas from the surrounding atmosphere, which contains more or less of this gas in every situation. If the barilha be not good, it will not afford any crystals in the above quantity of water; in this case it must be evaporated down one-third, and set by again*. When crystallized, the mother-water

* I frequently failed in the crystallization of soda in every degree of strength in the liquor, until evaporated down to perfect dryness, and redissolved again in fresh water, when it readily crystallized; but whenever this happened, the barilha was not of the best kind.

water is to be decanted off, and evaporated down one half; during this second evaporation, if it contain much sea-salt, that salt will make its appearance, and crystallize in the hot liquor; being no more soluble in hot water than in cold; this is separated by straining the solution while hot.

The liquor on cooling will deposit a second crop of crystals of soda, at the same time that the common salt will remain in solution. This process must be repeated, every subsequent mother liquor being partly evaporated, until as much as possible of the soda is obtained*.

This kind of treatment is sufficient for the bleacher's purpose, the quantity of alkali being his only object. For a

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* Good barilha contains from fifteen to sixteen per cent. of crystallized soda more than kelp.

more accurate analysis of the different materials contained in the barilha, see Kirwan on alkaline substances. *Irish transactions for 1789.*

The bleachers, when they use soda, avoid the expence and trouble of extracting it from the ashes; they charge the barilha in powder into a coarse linen bag, and boil it with the cloth, thus the alkaline part is extracted by the water, while the insoluble dregs remain behind in the bag, which should be of thick canvas, and being already pretty nearly in a caustic state, the mediation of quick-lime is unnecessary.

From the foregoing outlines of the general properties of alkalies, particularly those of pot-ash, which is the alkali most frequently used, it is easy to conceive what part it acts in the bleaching of linen.

The

The pot-ash or alkali, from its solvent power over the colouring matter, dissolves and separates the part immediately exposed to its action; that is to say, the part of it which rests superficially upon the fibres of the flax or thread; I say superficially, for it requires ten or twelve repeated boilings at least, with the alternate agency of the atmosphere, to separate the whole of the resin.

It might be asked, why such an active solvent as pot-ash should not carry away the entire of the resin at once, or at least as much as it *alone* could in any way separate.—This requires an explanation.

What appears to us to be a single ultimate fibre of flax in grey linen, is composed of a bundle of minute filaments, closely cemented or agglutinated

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ed together by the resinous matter ; therefore the pot-ash first used only acts upon the resin of the external coating of filaments, by which means they are loosened or separated, and exposed to the further action of the air.

The second boiling in pot-ash opens a second layer, and thus successively layer after layer until the entire is divided or opened to the centre.

Were the solution of pot-ash sufficiently strong to force its way at once to the centre, it would act upon the filaments themselves and destroy the texture of the cloth.

Each filament, after the process of pot-ash, retains an impregnation of colouring matter, so intimately united as to resist the further action of it. This can only be removed by the slow and gradual influence of the atmosphere.

But

But upon what principle does atmospheric air act? To understand this clearly, a previous knowledge of the nature and properties of it, is absolutely necessary.

The atmosphere in which we are immersed, and which furrounds this globe we inhabit, presses upon every square inch of its surface with about the weight of fourteen pounds. It is composed of two fluids or airs, mechanically mixed or diffused through each other (to compare denser bodies to rarer) like spirits and water, or sugar and water. One hundred parts of this air contain only twenty-seven, capable of supporting combustion or animal life; hence called vital air; the other seventy-three parts are the reverse of it in both these respects, and
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are called azotic gas*. By burning a body in the air, or by the respiration of animals, the vital part (now called oxygen gas†) is absorbed and separated from the azotic gas which is left behind, and which extinguishes bodies in combustion, and kills animals. Thus by combustion and respiration, an analysis of the atmosphere is effected.

Most inflammable bodies resist the attraction of the oxygenous part of the atmosphere in a common, or even in a much higher temperature. This proceeds

* Azot is derived from the Greek privative, particle *a* and *ζωή*, *vita* from its quality of killing animals in the act of breathing it.

† Called oxygen gas, as being one of the constituent principles of all acids, and it is supposed that an acid cannot exist without its presence. It is derived from the Greek *οξύς*, *acidum*, and *γενναί*, *gignor*. Hence a compound word signifying the acid-getting principle.

ceeds from two causes, which co-operate with each other: The one, from the attraction of caloric* (the matter of heat) to the gravitating or solid matter of oxygen gas. The other proceeds from the attraction of aggregation, or that influence which the most minute or ultimate particles of all solid bodies exert upon each other in a higher or less degree.

Thus, for example, Carbon or sulphur, although both highly inflammable, will not burn in contact with air, until this influence is in a great measure done away: This is effected by an high temperature, or in other words, by caloric, which penetrates between their particles. By this means they are removed beyond each others

* Caloric, the matter of heat, derived from *calor* the latin for heat.

others mutual influence, and consequently are left at liberty to direct the whole of their attraction towards the oxygenous part of the atmosphere.

The fire or caloric evolved during the act of combustion, comes from the air; the burning body, from superior affinity to its oxygen, only liberating the caloric from its chemical union with it: for caloric chemically united, is not felt, nor does it act as caloric;—just as crystallized salts which contain half their weight of water, will not wet or feel moist to the hand, or as sulphuric or nitrous acid, when united to an alkali, will not corrode.

From the above statement of the properties of oxygen gas and pot-ash, their *modus operandi* is very obvious. The pot-ash dissolves in each boiling,
a certain

a certain quantity of the colouring matter, and partly divides the filaments of each fibre of the flax; the oxygen gas, in its turn, unites to the portion still adhering to those filaments that eluded the action of potash, with which it forms carbonic acid gas*. The carbonic acid gas, from its volatility, flies off and mixes with the atmosphere.

Thus alternately, the one dissolving and the other burning out (for bleaching is slow combustion) the linen is whitened.

* Water is also formed in proportion to the quantity of hydrogen the resin contains.

SECTION III.

On bleaching with the oxygenated muriatic acid, and on the methods of preparing it.

AS atmospheric air is the most tardy menstruum in bleaching, requiring as many days and nights upon the green, as hours in pot-ash, it has ever been considered a great object to accelerate its combination with the colouring matter.

To promote the speedy action of atmospheric air, or rather the oxygenous part of it, in its ordinary elastic state, is well known to be impossible.

The present advanced state of chemistry, however, has enabled us indirectly
to

to obviate those obstacles. First, by condensing or combining the oxygen of the atmosphere, with substances to which it has great affinity; 2dly, by transferring it again from those substances, to others to which it has less affinity, but sufficient attraction to retain it in a concentrated state; and lastly, by steeping the linen in this last compound, which readily imparts its oxygen to the colouring matter.

In order to be more explicit, I will observe, that most metallic bodies have strong attraction to oxygen gas; for instance, lead when melted, or penetrated by a sufficiency of the matter of heat, so as to remove its aggregate influence, will drink in, if I may be allowed the expression, one twelfth of its own weight of oxygen.

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By this union, the lead loses its metallic brilliancy and cohesion, and assumes a loose earthy appearance and reddish colour, hence called *red-lead*.

When sulphuric acid (*oil of vitriol*) is poured upon red-lead, part of its oxygen is expelled in an aëriform state, that is, combined with caloric.

All metals thus united to oxygen, are called oxyds, distinguished from each other by the name of their respective metals; as for instance, oxyd of lead, of iron, of tin, of copper, &c.

Hence it appears, that metals, being in themselves fixed bodies, are the fittest substances to withdraw oxygen gas from the atmosphere, and to fix and concentrate it.

Some metals, but particularly a black semi-metallic substance called
manganese,

manganese, are found in the state of oxyds in the bowels of the earth. Manganese, from its great affinity to oxygen, is never found in any other state.

Manganese, as well as the rest of the oxyds, will not impart its oxygen to the colouring matter of the linen even in a boiling heat, when diffused in water, or in any temperature short of that which would destroy the texture of the cloth.

The oxygen therefore, thus collected, and attached to the metal must, as observed above, be transferred to another substance which retains it with less force, and consequently imparts it more freely to the surface of the linen. To effect this, the following are the materials and proportion used, viz. the oxyd of manganese sixty pounds, common

mon salt sixty pounds, and sulphuric acid fifty pounds* diluted with its own bulk of water†.

The manganese is to be finely ground and well mixed with the salt, and charged into a leaden still, sufficiently capacious to hold forty gallons of water, in order to allow space for the swelling of the ingredients during their chemical action upon each other, which, at the commencement of the process, is very considerable.

The still should be rather of a conical form, that is, somewhat progressively widening from the bottom to nearly

* Called sulphuric acid, sulphur being the basis, and oxygen the other principle.

† Forty-five pounds of good sulphuric acid, of such specific gravity that a pint will weigh twenty-nine ounces, will be found sufficient, when instead of plain water, the acidulous liquor in the middle receiver is added, which will hereafter be described.

nearly the upper part. The mouth or aperture of this apparatus is to be fitted with a flat or conical leaden cover, which is to rest in a groove, and the junctures are to be luted with well tempered blue clay.

An iron rod or upright, covered over with lead, is to be fixed in the centre of the cover as tight as possible, without impeding a rotatory motion.— It should reach to the bottom of the still with prongs or wings to that part which enters the charge, in order, occasionally, to mix the materials, and to bring all their parts to act upon each other.

A leaden funnel should also be inserted, air tight, into another part of the cover, with a long stem which should curve upright a few inches underneath it. This will prevent the
escape

escape of the elastic fluids, disengaged, during the charging of the sulphuric acid upon the materials, which would be highly injurious to the workmen.

It is, I should suppose, unnecessary to explain the principle upon which the curved funnel acts, suffice it then to say, that two columns of sulphuric acid of equal weight, the one in the curved part, and the other in the perpendicular, rest in the stem of the funnel, which balance each other, and which, by their gravity, press against the expansive force of the internal elastic fluid.—Were the stem of the funnel straight, the elastic fluids would sometimes make their escape, even against the current of the sulphuric acid passing through it.

A leaden

A leaden tube, three inches diameter in the bore, and of convenient length, should communicate from the cover to a leaden receiver large enough to hold about eight gallons.

This is to contain water only, and should betwo-thirds filled with it; another tube of the same diameter with the former should pass from this receiver, above the level of the water, to the upper part of a vessel, or cask sufficiently capacious to hold eight hundred gallons of water, and eighty pounds of well-slaked and sifted quick-lime.

As the lime, from its superior specific gravity to water, would sink in it and fall to the bottom of the receiver, it is necessary to use some means of keeping it suspended. For this purpose, an upright agitator, such as was recommend-

ed for the leaden still, should be adopted here; but the latter is to be of wood. By this contrivance a rotatory motion may be communicated to the liquor at pleasure. Two or three boards or wings should also be fixed to the sides of the cask at right angles; the liquor, by dashing against those, will acquire additional motion. Thus a continual surface of fresh lime liquor will be presented during the process, to the oxygenated muriatic acid gas, which will much facilitate its condensation.

This short description will give a sufficient idea of the apparatus, and of the expence attending it. Those who use it, I understand, find it very convenient, but doubtless practice will improve it. The apparatus itself may be seen at work at the bleach-green of

Charles

Charles Duffin, at Dungannon*. A Mr. Tennant who works for him, and who, it seems, is very expert at the process, may be employed by the different bleachers, until they get into the method of managing it themselves.

As the lead would be liable to melt, if exposed to a naked fire, in consequence of the solid materials resting upon the bottom of it, and as the heat of boiling water is sufficient to work the charge, the still should be placed in a copper or iron boiler, large enough to admit a sufficient quantity of water to surround it.

The apparatus being thus disposed, it remains now to attend to the theory and management of the process.

The

* Since the above was written, I have been informed, that no less than thirty such apparatus are now used in the north of Ireland.

The oxyd of the manganese and salt being charged into the still, the cover luted on, and the whole of the apparatus being connected together, the sulphuric acid is to be gradually poured on by means of the curved funnel. The sulphuric acid, the instant it comes in contact with the other materials, acts partly upon the salt, while another portion of it unites to the manganese.

Manganese is an oxyd, a metal saturated with oxygen gas: Common salt is composed of muriatic acid gas and an alkaline salt called soda, the same which barilha affords: Manganese has a greater affinity to sulphuric acid than it has to the oxygen*, and the soda of the salt greater affinity to sulphuric acid than to the muriatic acid gas; hence it necessarily

* The quantity of oxygen necessary to metallic solution is excepted here.

cessarily follows, that these two gases, (or rather their gravitating matter,) must be liberated from their former union in immediate contact with each other; and, although they have but a weak affinity to one another, they unite in their nascent state, that is to say, before they individually unite to caloric, and separately assume the gaseous state; for oxygen gas, and muriatic acid gas, already formed, will not unite when mixed, in consequence principally of the distance at which their respective atmospheres of caloric keep their gravitating particles asunder*.

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* Common muriatic acid, that is, water saturated with muriatic acid gas, poured upon the manganese, will afford the oxygenated muriatic gas; but as the acid must first be disengaged from the salt, by means of sulphuric acid, and distilled, this would be an expensive method.

The compound resulting from these two gases, still retains the property of assuming the gaseous state, and is the oxygenated muriatic gas.

Heat should not be applied until the first action of the sulphuric acid upon the dry materials, (which is rather considerable) nearly subsides, otherwise the oxygenated muriatic gas will be generated faster than it can be condensed, which would endanger a rupture of the vessels.

At the commencement of the process, a portion of the muriatic acid gas escapes uncombined with oxygen gas, which were it condensed in the oxygenated liquor, would be rather injurious to it; but common muriatic gas, being more condensable in water than the oxymuriatic gas, is arrested and condensed in the middle or leaden receiver;—such is the principal use of this part
of

of the apparatus. The pure oxygen gas passes into the wooden receiver, where it is absorbed by the lime, and the compound, being a soluble substance, is dissolved by the water in the condenser.

This liquor is the oxygenated muriate of lime, and may, soon after the process is over, be drawn off clear from the insoluble dregs, which in a short time subside to the bottom. In this state, it is of sufficient strength to bear thrice its bulk of water for the purpose of bleaching.

The residuum in the still consists of sulphat of manganese, sulphat of soda, a small portion of muriate of manganese, and some oxyd of manganese which escaped the action of the acids. The latter substance being insoluble, the different salts may be separated from it by

by means of hot water. This residuary manganese, when well washed and dried, may be used over again in a fresh charge.

The oxygenated muriatic acid gas was first discovered by the immortal SCHEELE, a celebrated Swedish chemist.

The application of it in the art of bleaching, was reserved for BERTHOLLET, a famous French chemist, who first recommended it condensed in plain water. This method, however well it may answer in small experiments, was afterwards found inconvenient in the large way; for first, the water condenses the gas so very sparingly, that the apparatus used must necessarily be upon too large and expensive a scale. 2dly, Water condenses the gas so slowly, the process must be tedious, for the charge cannot be worked faster than the gas is absorbed;

ed; and lastly, water retains the gas so very weakly, that it is continually flying off during the application of the liquor, and is not only lost, but highly injurious to the workmen.

Hence this method had been afterwards superseded by a solution of pure pot-ash, which was found to obviate the above inconveniencies, by more effectually condensing and fixing the gas.

Although the oxygenated muriate of pot-ash has been used with great advantage by the paper-makers, it does not appear to have made any great progress in our bleach-greens.

What success the oxygenated muriate of lime may be attended with, I will not at present take upon me to say; this can only be ascertained by the progress it will make amongst the most

H enlightened



enlightened of the bleachers, who are ever ready to adopt every means likely to save labour and expence. I must, however, observe, from a series of comparative experiments which I made upon it and the oxygenated pot-ash, by order of the Linen Board, that the former, as being cheaper, and less liable to injure the texture of the cloth, has decidedly the preference.

By the experiments I made, it appeared, that six boilings in pot-ash and alternate steepings in the oxygenated lime-liquor, bleached the linen well; but it was liable to turn yellowish by boiling in soap, or repeated washings: Hence it was found necessary to bleach the linen partly in the common way first.

According

According to the information I have received from Mr. Duffin, the following is the method practised by those bleachers who use the oxymuriate of lime, viz. 1st, four boilings in pot-ash, and four weeks exposure to the air, 2dly, two immersions in the oxygenated lime, with an alternate boil in pot-ash, and a week's grafs between each boiling or immersion; after this treatment the linen is fit for the boards and fours.

During the summer months two boilings in pot-ash, and a fortnight's exposure to the air is sufficient to prepare the linen for the oxygenated liquor; after this, three boilings in the alkali, and alternate steeps in the oxygenated muriate of lime will finish it.

From

From the foregoing view of the theory and practice of bleaching, it is evident, that whether the linen be bleached in the usual way by the tardy process of exposing the cloth to the action of the oxygen gas of the atmosphere, or by the more expeditious method of using the oxygenated liquor as an auxiliary, the use of potash, or a *substitute* for it, is indispensably necessary. How far I have been successful as to such a substitute, the following section will evince.

SECTION

SECTION IV.

*On sulphuret of lime, as a substitute for
pot-ash.*

SINCE I had the honour of being appointed chemist to the Linen Board, which is now more than three years, I have allotted a considerable portion of my time and attention to the investigation of the principles of that science, applicable to the art in which I am thus more particularly interested. It appeared, that until pot-ash could be dispensed with, we must for ever remain in the power of foreign nations as to our staple commodity: Observing also, that all the late improvements in bleaching were exclusively confined to the one object—that of imparting

parting oxygen to the cloth, in a safe and expeditious manner, but that there had been no effort made to supersede the necessity of pot-ash, by far the most expensive and uncertain article employed by the bleacher, and for which he is entirely dependent upon foreign markets; I directed my attention chiefly to discover a substitute for pot-ash; which, provided it should be of Irish production, though it might be equally expensive, I conceived would be of the utmost national importance. Impressed with these ideas, I undertook a series of experiments with that view.

To enumerate the many disappointments and failures I experienced during my investigation, would be endless, and an unnecessary intrusion upon

upon my reader.—Knowing, from an important observation of Mr. Kirwan, that saline hepars, or the combination of an alkali with sulphur, might, from its detergent properties be advantageously employed in bleaching, as a substitute for mere alkali, by an obvious analogy I was led to expect a similar effect from calcareous hepar, or, more properly speaking, sulphuret of lime, being a combination of lime and sulphur.

In these expectations I was not disappointed, but at that time (about three years since) I contented myself (rather through necessity, for large cities are very unfavourable to experiments on bleaching by exposure to the atmosphere,) with pointing it out to some of the principal bleachers from the north then in town, earnestly recommending

commending it to them to give it a fair trial with, and without pot-ash. Since that time, alkaline salts having become progressively dearer, and in consequence of a late proposal of substituting lime for pot-ash, in condensing the oxymuriated gas, I was instigated to resume the subject, and make further and more varied trials. The result of which has been, that the use of the sulphuret of lime may be most advantageously combined with that of the oxymuriated lime, and that thus cloth may be perfectly whitened without the use of a particle of alkali. This then alone would seem to give it a decided preference over the methods at present in use, while at the same time it possesses peculiar advantages, and is exempt from the principal objections to which other *substitutes* are liable;

liable; for 1st quicklime and sulphur, the materials of which the *calcareous bepar* consists, are both articles of trivial expence, especially as the latter enters but sparingly into the composition; 2^{dly}, their combination is effected in the easiest and most expeditious manner possible, and perfectly level with the capacity of the meanest workman; 3^{dly}, as the manner of its application is, by steeping the cloth in it cold, the saving of fuel is a matter of great magnitude; and lastly, there is no danger to be apprehended in the use of it, from the unskilfulness or negligence of the workman, as it appears to be incapable of injuring the texture of the cloth.

The *sulphuret of lime* is prepared in the manner following:—Sulphur, or brimstone in fine powder, four pounds, lime well flaked and sifted twenty
I pounds,

pounds, water sixteen gallons ; these are all to be well mixed and boiled for about half an hour in an iron vessel, stirring them briskly from time to time. Soon after the agitation of boiling is over, the solution of the sulphuret of lime clears, and may be drawn off free from the insoluble matter, which is considerable, and which rests upon the bottom of the boiler*. The liquor in this state, is pretty nearly of the colour of small beer, but not quite so transparent.

Sixteen gallons of fresh water are afterwards to be poured upon the insoluble dregs in the boiler, in order to separate the whole of the sulphuret from them.

When

* Although *lime* is one of the constituent principles of the *sulphuret*, yet being so intimately united to the sulphur, it has no longer the property of lime ; upon the same principle that *sulphuric acid* in sulphat of pot-ash, has not the property of that acid.

When this clears (being previously well agitated) it is also to be drawn off and mixed with the first liquor; to these again, thirty three gallons more of water may be added, which will reduce the liquor to a proper standard for steeping the cloth.

Here we have, (an allowance being made for evaporation, and for the quantity retained in the dregs) sixty gallons of liquor from four pounds of brimstone.

Although sulphur by itself is not in any sensible degree soluble in water, and lime but very sparingly so, water dissolving but about one seven-hundredth part of its weight of lime; yet the sulphuret of lime is highly soluble*.

* When the above proportion of lime and sulphur is boiled with only twelve gallons of water, the sulphuret partly crystallizes upon cooling, and when once crystallized, it is not easy of solution.

SECTION V.

On bleaching with the sulphuret of lime.

WHEN the linen is freed from the weaver's dressing, in the manner already described, it is to be steeped in the solution of sulphuret of lime (prepared as above) for about twelve or eighteen hours, then taken out and very well washed; when dry, it is to be steeped in the oxymuriate of lime for twelve or fourteen hours, and then washed and dried. This process is to be repeated six times, that is, six alternate immer-

immersions in each liquor, which I found sufficient to whiten the linen.

When I submitted the linen to six boilings in pot-ash, and to six immersions in the oxygenated liquor, it was not better bleached than the above.

The three first boilings in pot-ash, it is true, produced a somewhat better effect than as many steeps in the sulphuret; but towards the conclusion, that is, when the linen was bleached, the smallest difference was not observable as to colour. The linen bleached with the pot-ash was thinner, or more impoverished than that treated with sulphuret, and the latter stood the test of boiling with soap much better than the former, although it did acquire a slight yellowish tinge, which I should suppose a week's, or at most, a fortnight's grass, as they term it, would remove.

I con-

I contrasted the effects of hot and cold sulphuret in various temperatures, and although the difference appeared in favour of the hot liquor, yet it was so trifling as not to deserve consideration, or the expenditure of the smallest quantity of fuel.

When I steeped the linen in the sulphuret first, and afterwards boiled it in pot-ash, and then immersed it once in the oxygenated liquor, a better effect was produced, than from two previous boilings in pot-ash, or from two steeps in the sulphuret; so that the two substances seem to co-operate with each other.

Indeed, from what I have seen, two successive steeps in fresh sulphuret, previous to the immersion in the oxygenated liquor, seemed to afford very little

tle better effect than a single one, which is not the case with respect to pot-ash.

It was observable, that the cloth was invariably thicker or more swelled coming out of the sulphuret, than after being boiled in pot-ash, and remained so when even washed and dried.

It appears to me, that the sulphuret opens the fibres of the linen more speedily and better than the latter, by softening and swelling, rather than by dissolving, the resinous or colouring matter. This accounts for the better effect of pot-ash upon the linen when previously steeped in the sulphuret, than when used by itself.

Probably those bleachers who do not at present find it convenient to use the oxygenated liquor, but continue to bleach by exposure to air, may derive some

some advantage from this, by using the sulphuret and pot-ash conjointly or alternately.

Mr. John Duffy, of Ball's-bridge, (who from his knowledge of chemistry is very well acquainted with the principles of bleaching) was kind enough to repeat the above experiments, and his report to me corresponded with my own observations.

It is almost impossible to ascertain to the full extent, more especially by small experiments in an elaboratory, the many advantages any substance not hitherto used in bleaching, will afford by varying the mode of application.

The experimenter does a great deal by discovering the efficacy, proving the practicability, and ascertaining the safest and most economical method of directly

directly using it, and also the best proportion of it. Before he can arrive at any one of these, many a round of changes are necessary; indeed a greater number than any man who is not used to experiments can be aware of. But I should hope, that the bleacher need not hesitate to use it in the state in which I present it to him, more especially as he runs no risque of injuring the cloth with it. If he can make more of it hereafter, I shall feel happy upon the occasion; no discovery was ever brought to perfection at once.

How gradually, and yet how progressively the steam engine, from its first invention by the Marquis of Worcester, was brought to its present degree of perfection? Undoubtedly, it was just so with respect to alkalies,

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the substances now used by the bleachers, it must have taken a considerable time after their first application in bleaching, before they could be made the most of.

I will now conclude by pointing out the advantage likely to accrue from the use of the sulphuret, to the nation, and also the saving to the individual.

By the information I have had from the Custom House, it appears that the average importation of potash, pearl-ash and barilha, the last twelve years, amounts to about 5066 tons annually; about one half of this, (2533 tons) is barilha. The average price of barilha the last three years, has been forty pounds a ton, so that the value of the quantity imported is

101,323

101,323 pounds; of this only half, or thereabout, I understand, is used in bleaching, the remainder being converted into soap.

Most of the pot and pearl-ash is consumed by the bleachers, and the average price of it the last three years has been sixty-five pounds a ton, consequently, the value of 2,533 tons is 164,645 pounds.

Hence it seems, that the quantity of foreign alkalies imported into the kingdom every year, amounts to 265,968 pounds; and that the quantity used in bleaching alone, amounts to about 215,307 pounds annually.

The average price of brimstone for the last three years, is about twenty-five pounds a ton, which is at the rate nearly of two pence farthing a pound;

pound; four pounds of brimstone, and twenty pounds of lime, as already observed, will produce sixty gallons of liquor. In this country, twenty pounds of lime may be valued at about four pence, so that the bleacher may have the sixty gallons at the expence of 1s. 1d.

By what I could learn from different bleachers, the common allowance of alkali for sixty gallons of water, is six pounds of barilha or four pounds of pot-ash at the very least, and most bleachers use more than this. The price of four pounds of pot-ash at the rate of sixty-five pounds a ton, is about two shillings and four pence, which is two pence more than double the price of the sulphuret; but as the brimstone must be ground, an allowance

ance should be made for it ; and being easy of pulverization, a farthing per pound is an ample consideration for the expence attending it.

The saving of fuel only remains now to be taken into consideration ; and as this cannot be calculated with any degree of accuracy, I shall content myself by particularizing facts. In the first place, but sixteen gallons of liquid are to be boiled in preparing sixty gallons of the sulphuret, while the whole sixty gallons must be boiled when the alkali is used ; hence it might appear that two thirds of the fuel are saved in the quantity of liquor, but it is not quite so much, suppose we estimate it at one half, which is rather under-rating it. Let us add to this the time necessary to boil the
different

different liquors; the sulphuret requires but about half an hour, and the alkaline lixivium at the very least, seven hours to boil the linen in it, which is in the proportion of one to fourteen.

The saving altogether to the bleacher from this statement, is obviously very considerable; and as the Wicklow copper mines are sufficient to supply the whole kingdom, or indeed two such kingdoms with abundance of sulphur, let the consumption be ever so great, the entire of the alkali, or 215,307 pounds must be annually saved to the nation.

But suppose two thirds only of the quantity of alkali generally consumed in bleaching were dispensed with

with by the use of the sulphuret (which is a supposition not warranted by my experiments) still the saving to the nation and to the individual, must evidently be great indeed.



THE END.

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